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Interrelationships and Variability Studies for Grain Yield and its Various Components in Chickpea (*Cicer arietimum* L.)

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ABSTRACT

Eighteen elite genotypes (848, 4047, 810, 447, BRC-27, ILC-918, 1036, 4012, 109, 290, 5006, 932, 107, BRC-20, 406, 1028, 228 and 928) and two varieties (Bittal and CM-72) of chickpea were used to analyze the means and components of variability (genetic, phenotypic and environmental), heritability (h^2_{bs}), genetic advance and interrelationships (genetic and phenotypic) for yield and various other yield components. The results suggested that pods per plant, seeds per plant, 100-seed weight and total weight of plant might be useful while selecting for high yielding genotypes of chickpea. It was also suggested from the mean values of hundred seed weight, total weight of plant and seed yield per plant that chickpea genotypes 932, BRC-27 and Bittal-98 may be used as parents in further breeding program to develop high yielding cultivars.

Key Words: Chickpea; Variation; Correlation coefficients; Heritability

INTRODUCTION

Chickpea (*Cicer arietinum*) is the second most important pulse crop in the world. It occupies about 10.2 million hectare area with total production 7.9 million tones (Singh, 1997). The leading chickpea growing countries in the world are India, Pakistan, Mexico, Turkey, Ethiopia and Burma. It is principal rabi pulse crop of Pakistan, mostly grown in the vast rainfed areas. The major chickpea production belt is Thal consists of districts of Bhakhar, Mianwali, Layyah, Khushab and parts of the Jhang. It is also grown in Potohar consists of Attock, Rawalpindi, Jehlum and Chakwal districts. Chickpea is the cheapest and readily available source of protein (17%), fats (23%) carbohydrates (61.2%), ash (2.7%) and 9.8% moisture (Smartt, 1976). Unfortunately, despite its nutritional values and economic importance, chickpea production is very low per hectare in the country. This is primarily due to poor genetic makeup of cultivars available. Genetic variability is a prerequisite for any breeding program, which provides opportunity to a plant breeder for selection of high yielding genotypes. However information on the associations between yield and its various components provide the basis for the selection of improved varieties. The objective of this study was to estimate the direct and indirect contribution of different yield components to the overall seed yield in chickpea.

MATERIALS AND METHODS

The experiment was conducted during growing season 2001-2002. Eighteen elite genotypes (848, 4047, 810, 447, BRC-27, ILC-918, 1036, 4012, 109, 290, 5006, 932, 107, BRC-20, 406, 1028, 228 & 928) and two varieties (Bittal & CM-72) were grown by using randomized complete block design with three replications. All the cultural practices were carried out throughout crop growing season. Number of days to flowering was recorded at the time when at least 50% plants showed the appearance of first flower. Days taken to maturity were calculated from the date of planting to the date when 90% plot turned brown and ready for harvest. At maturity data were recorded for yield and its various components and subjected to statistical analysis (Steel & Torrie, 1980). Genotypic and phenotypic correlation coefficients were calculated as Kown and Torrie (1964). The estimation of heritability and genetic advance were calculated as described by Falconer (1989)

RESULTS AND DISCUSSION

Chickpea genotype (Table I) Bittal-98 had taken significantly less number of days to flowering than 5006, 447,4047, CM-72, 848, 107, 928, 912, 1028, 290, 810, 406, 4012 and 1036. It was followed by 109, BRC-20, 288, BRC-27, ILC-918 chickpea genotypes, which had significantly taken less number of days to flowering than 5006, 447, 4047, CM-72. Bittal-98 and ILC-918 had taken significantly less number of days to maturity than 109, BRC-20, BRC-27, 1036, 932, 928, and 447. These were followed by chickpea genotypes 288, 4012, 810, 290, 1028 and 107. Chickpea genotypes (109, 288, 1036 & 4047) had significantly more number of primary branches per plant as compared to Brittal-98, 406, 932 and 5006. BRC-27 had significantly more number of secondary branches than 288, 1036, 810, 848 and 447 chickpea genotypes (Table I).

Chickpea genotypes (Bittal-98 & 109) had lesser plant height than BRC-20, BRC-27, ILC-918, 4012, 406, 810, 290, 1028, 932, 107, 848, 4047 and 5006. In case of pods

per plant, chickpea genotypes (5006, 848 & 406) had significantly more pods per plant than 109, 288, ILC-918, 4012, 290, 928, 107, 4047 and 447. The chickpea genotypes (4047, BRC-27 & Bittal-98) had significantly more seeds per pod as compared to 288, ILC-918, 1036, 406, 1028, 932, 107 and 5066. In case of seeds per plant, 5006, 848 and 1058 chickpea genotypes had more number of seeds per plant than 447, 4047, 107, 928, 290, 4012, ILC-918, 288. There were significant differences between Bittal-89 and BRC-27 for hundred seed weight. These both had significant greater hundred seed weight than all other genotypes. Bittal-98 and BRC-27 were also found higher yielder than all other genotypes except 932. Similarly these both had higher total weight per plant than all other genotypes, except BRC-27 was not found significantly different than CM-72, 932 and 1028 (Table I). The results suggested sufficient variability among genotypes for days to flowering and maturity, primary and secondary branches per plant, plant height, seeds per plant, seeds per pod, 100-seed weight, total weight of plant and seed yield per plant. Many research workers reported genotypic variability in chickpea, such as Rehman *et al.* (1996) for number of seeds per pod, Tripathi (1998) for seeds per plant, Kumar *et al.* (1999) and Nimbalkar (2000) for hundred seed weight and Wahid and Ahmad (1999) for yield per plant.

Coefficients of variation. Low coefficients of variation (1.07-6.22%) were found for days to flowering and maturity, primary and secondary branches per plant, plant height, pods per plant, seeds per pod, seeds per plant, 100-seed weight, total weight of plant and seed yield per plant in chickpea (Table II). The phenotypic coefficients of variation were also found lower for days to flowering (1.78%), days to maturity (1.70%), primary and secondary branches per plant (2.01 & 3.84% respectively) and seeds per pod (4.10%). The phenotypic coefficients of variability were found moderate for plant height (9.52%), pods per plant (8.48%), seed per plant (8.40%), 100-seed weight (10.96%), total weight of plant (11.18%), and seed yield per plant (11.89%). Genetic coefficients of variability were observed lower for days to flowering (1.54%), days to maturity (1.50%), primary and secondary branches per plant (1.45 and 2.71% respectively), and seeds per pod (3.83%). While they were observed moderate for plant height (9.37%), pods per plant (7.95%), seeds per plant (7.80%), 100-seed weight (10.84%), total weight of plant (10.57%) and seed yield per plant (11.34%). Low environmental coefficients of variation values observed for all traits in this study ranged between 0.80-3.59% (Table II). Rao and Kumar (2000), and Singh *et al.* (1990) reported low variability for days to 50% flowering and days to maturity. High estimates of genetic variability for primary and secondary branches per plant and pods per plant were reported by Chavan *et al*. (1994), while moderately high phenotypic coefficients of variability was noted by Arora (1991) for primary branches per plant and 100-seed weight. Khan and Sharma (1999) reported high genetic coefficient of variation for secondary branches per plant. Rehman *et al.* (1996), Wahid and Ahmed (1999) reported high estimate of genetic coefficient of variability for plant height and seeds per pod. Tripathi (1998) reported high genetic coefficients of variability for seeds per plant and seed yield per plant.

Heritability (h2 bs) and genetic advance (GA%). High heritability estimates (Table II) were observed for plant height (96.9%), pods per plant (88.0%), seeds per pod

Table I. Means of different chickpea genotypes for yield and various yield parameters

Genotype	Parameters										
	Days to flowering	Days to maturity	Primary branches per plant	Secondary branches per plant	Plant height (cm)	Pods per plant	Seeds per pod	Seeds per plant	100-seed weight (g)	Total weight of plant (g)	Seed yield per plant (g)
5006	121.7a	163.0abcde	2.33b	6.13abc	81.7a	68.60ab	1.52f	122.6a	16.87i	44.86cdef	21.32cde
447	121.7a	164.3abc	2.40ab	5.50d	66.67de	59.63efgh	1.65abcd	109.0cde	19.60ef	44.26defg	20.92cde
4047	120.7ab	161.7bcde	2.47a	5.87abcd	72.03c	57.10fghi	1.73a	105.5def	18.27gh	40.98fgh	18.26fgh
CM-72	120.3abc	162.7abcde	2.37ab	5.80abcd	59.00g	61.90cdefg	1.63abcde	115.1abcde	18.87fg	49.11bcd	22.04bcd
848	119.7abcd	163.0abce	2.43ab	5.63cd	67.23d	69.60a	1.653abcde	123.1a	17.80ghi	46.58cde	21.96cde
107	119.3abcde	163.0abcde	2.40ab	5.90abcd	67.47d	61.37defg	1.57cde	112.3cde	21.0cd	44.71cdef	22.0bcd
928	119.0abcde	164.0abc	2.43ab	5.83abcd	65.23de	56.07ghij	1.62abcde	99.5ef	20.50de	41.92efgh	19.83defg
932	119.0abcde	166.0a	2.33b	6.00abcd	66.83d	66.10abcd	1.57def	101.4abcd	21.57c	50.09bc	24.43ab
1028	118.7abcde	163.7abcd	2.43ab	6.23abc	78.50ab	65.93abcd	1.61cde	122.1ab	19.97d	49.71bc	23.47bc
290	118.3abcde	163.0abcde	2.43ab	6.23ab	68.67d	50.50j	1.67abcd	91.9f	18.30gh	41.28efgh	19.20h
810	118.3abcde	161.3cde	2.40ab	5.63cd	67.33d	64.23abcde	1.69abc	115.7abcde	17.00i	36.36h	19.34efgh
406	117.3abcde	161.7bcde	2.33b	6.03abcd	67.13d	67.73abc	1.55def	121.8abc	20.87cd	42.92cd	23.03bc
4012	117.0cde	161.3cde	2.37ab	5.73abcd	80.47a	57.30fghi	1.657abcde	104.3def	18.60fgh	41.82efgh	19.99def
1036	117.0cde	164.3abc	2.47a	5.73bcd	65.73de	61.70cdefg	1.53ef	114.4abcde	18.13gh	45.53cdef	21.32cde
ILC-918	116.7def	159.7e	2.43ab	6.13abc	75.90b	54.47hij	1.55def	100.0def	17.60hi	39.14gh	17.47gh
BRC-27	116.7def	165.0ab	2.43ab	6.30a	78.87ab	63.73abcd	1.730a	120.6abcde	23.93b	57.73a	26.72a
288	116.7def	162.7abcde	2.47a	5.66cd	65.83de	53.80ij	1.53ef	97.2ef	20.63cde	41.40efgh	19.48defgh
BRC-20	116.0ef	164.0abc	2.43ab	6.00abcd	75.53b	63.70abcde	1.64abcd	115.4abcde	20.47de	45.28cdef	21.28cde
109	116.0ef	164.3abc	2.47a	5.77abcd	60.87fg	61.30efgh	1.610abcde	115.0abcde	18.83fg	44.74cdef	21.40cde
Bittal-98	113.3f	160.3de	2.33b	5.97abcd	63.57ef	62.93bcdef	1.71ab	114.3abcde	25.13a	54.15ab	26.05a

Note: means sharing the same letters are non-significant at 5% level of probability.

(87.1%), seeds per plant (86.2%), 100-seed weight (97.7%), total weight of plant (89.8%) and seed yield per plant (90.9%) with genetic advance 11.3, 8.05, 0.10, 4.28, 3.71, 8.01 and 4.06, respectively. The estimates of heritability were found moderate for days to flowering and maturity, primary and secondary branches per plant with genetic advance 2.76, 1.69, 0.04 and 0.20 respectively. Agrawal (1985), Mirsa (1991), Khorgade *et al*. (1985), Jahgridar *et al*. (1994) and Arun and Ram (1998) reported high heritability estimates for days to flowering, pods per plant and 100-seed weight. This may be due to the different genetic materials used and conditions under which experiment was conducted. Agrawal (1985) and Mirsa (1991) reported high heritability for days to maturity. Low estimates of heritability were reported by Rao *et al*. (1994) for secondary branches per plant but high for plant height. Khorgade *et al*. (1985) reported high heritability estimates for seeds per pod. High heritability estimates were reported by Tripathi (1998) and Kumar *et al*. (1999) for seed yield.

Correlation coefficients. Non significant relationships existed between plant height, seeds per pod, seed yield per plant and days to flowering both at genetic and phenotypic levels. Seed yield per plant was positively correlated with days to maturity, pods per plant, seeds per plant, 100-seed weight and total weight of plant both at genetic and phenotypic levels. Seed yield per plant was negatively correlated with primary branches per plant both at phenotypic and genetic levels. Seed yield per plant had a positive correlation at phenotypic but non-significant at genetic level (Table III). Total dry weight of plant had positive correlation with pods per plant, seeds per plant and 100-seed weight both at genetic and phenotypic levels. It was also negatively correlated with primary branches per plant both at genetic and phenotypic levels. Hundred seed

Table II. Coefficient of variation (CV%), phenotypic coefficient of variation (PCV%), genetic coefficient of variation (GCV%), environmental coefficient of variation (ECV%), broad-sense heritability (h^2_{bs}) and genetic advance (GA%) for yield and its various components in chickpea

Trait	CV%	PCV%	GCV%	ECV%	h^2_{bs}	GA%
Days to flowering	1.54	1.78	1.54	0.89	74.9	6.76
Days to maturity	1.07	1.70	1.50	0.80	60.4	1.69
Primary branches per plant	2.40	2.01	1.45	1.39	52.3	0.04
Secondary branches per plant	4.73	3.84	2.71	2.73	49.6	0.20
Plant height (cm)	2.90	9.52	9.37	1.67	96.9	11.31
Pods per plant	5.10	8.48	7.95	2.94	88.0	8.05
Seeds per pod	2.55	4.10	3.83	1.47	87.1	0.10
Seeds per plant	5.39	8.40	7.80	3.11	86.2	14.28
100-seed weight (g)	2.90	10.96	10.84	1.67	97.7	3.71
Total weight of plants (g)	6.18	11.16	10.57	3.57	89.8	8.01
Seed yield per plant (g)	6.22	11.89	11.34	3.59	90.9	4.06

Table III. Genetic (in parenthesis) and phenotypic correlation coefficients between seed yield and its various components in chickpea

	Days to maturity	Primary branches per pant	Secondary branches per plant	Plant height (cm)	Pods per plant	Seeds per pod	Seeds per plant	100-seed weight (g)	Total weight of plants (g)	Seed yield per plant (g)
Days to flowering	(0.426 NS) 0.249 NS	(-0.040 NS) -0.895**	(-0.324 NS) -0.182 NS	(0.106 NS) 0.088 NS	(0.160 NS) 0.131 NS	(-0.174 NS) -0.100 NS	(0.120 NS) 0.091 NS	(0.602*) 0.508**	(-0.274 NS) -0.244 NS	(-0.287 NS) -0.263 NS
Days to maturity		(0.251 NS) 0.172 NS	(0.456 NS) 0.228 NS	(-0.058 NS) -0.072 NS	(0.319 NS) 0.237 NS	(-0.192 NS) -0.109 NS	(0.415 NS) 0.302 NS	(0.212 NS) 0.170 NS	(0.384 NS) 0.309 NS	(0.466*) 0.358*
Primary branches per plant			(-0.132 NS) -0.088 NS	(-0.080 NS) -0.030 NS	(-0.577*) -0.454**	(0.137 NS) 0.098 NS	(-0.526*) -0.398*	(-0.278 NS) -0.244 NS	(-0.256 NS) -0.370*	(-0.653*) -0.424**
Secondary branches per plant				(0.459*) 0.350*	(0.012 NS) 0.037 NS	(-0.045 NS) -0.057 NS	(0.083 NS) 0.070 NS	(0.605*) 0.434*	(0.458*) 0.335*	(0.460*) 0.335*
Plant height (cm)					(0.116 NS) 0.093 NS	(-0.001 NS) 0.001 NS	(0.123 NS) 0.093 NS	(-0.139 NS) -0.140 NS	(-0.018 NS) -0.018 NS	(-0.032 NS) -0.036 NS
Pods per plant						(-0.081 NS) -0.087 NS	(0.999*) 0.976**	(0.104 NS) 0.103 NS	(0.656*) 0.644**	(0.666*) 0.667**
Seeds per pod							(-0.018 NS) -0.047 NS	(0.282 NS) 0.254 NS	(0.272 NS) 0.194 NS	(0.192 NS) 0.123 NS
Seeds per plant								(0.165 NS) 0.158 NS	(0.731*) 0.726**	(0.729*) 0.733**
100-seed weight (g)									(0.772*) 0.711**	(0.798*) 0.748**
Total weight of plants (g)										(0.986*) 0.977**

NS= non-significant, * = significant at 5% level of significance, ** = significant at 1% level of significance.

weight was negatively correlated with days to flowering, but positively with secondary branches per plant both at genetic and phenotypic levels. Seeds per plant had a negative correlation with primary branches per plant both genetic and phenotypic levels. It also had a positive one with pods per plant at these levels. Pods per plant had a negative correlation with primary branches per plant both at genetic and phenotypic levels. There was a significant and positive correlation with secondary branches per plant (Table III). Similar results were reported by Wahid and Ahmed (1998) and Yadav and Sharma (1998) that seed yield had negative and significant correlation with days to flowering. Arora and Jeena (1999) also reported similar results that seed yield per plant was significantly and positively correlated with days to maturity. Shinde and Saraf (1991), Khedar and Maloo (1999), Vijayalakshmi *et al.* (2000), reported positive correlation of seed yield per plant with number of primary branches per plant. Bakhsh *et al.* (1998) and Saleem *et al.* (1999) reported that seed yield per plant was positively correlated with secondary branches per plant and seeds per pods.

CONCLUSIONS

It is concluded from the genetic coefficient of variability, heritability, genetic advance and interrelationship estimates that pods per plant, seeds per plant, 100-seed weight and total weigh of plant are important characters and may be used as selection criteria for developing high yielding genotypes of chickpea.

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